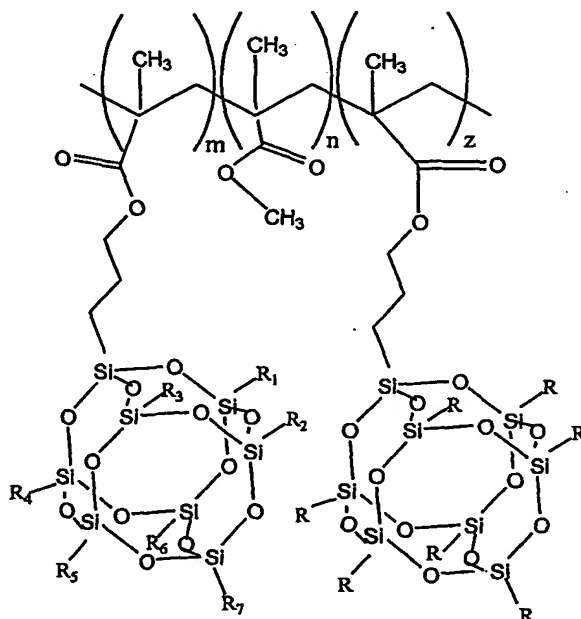


Claims

1. A microfluidic device comprising

a body structure provided with a microchannel and an inlet port and an outlet port, wherein said inlet port and outlet port are formed on an exterior surface of said body structure and are in fluid communication with said microchannel, wherein said microchannel has an interior surface that is coated with a polymer comprising monomer units represented by the formula:



wherein R, R₁, R₂, R₃, R₄, R₅, R₆, and R₇ are independently selected from the group consisting of C₁-C₁₈ alkyl, C₂-C₁₈ alkenyl, C₂-C₁₈ alkynyl, C₁-C₈ alkylcarboxyl, C₁-C₈ alkyl(NR₂₀R₂₁R₂₂)⁺, C₁-C₈ alkyl(NR₂₁R₂₂), C₁-C₈ alkyl(NHR₂₂), C₁-C₈ alkylsulfate, C₃-C₈ cycloalkyl, and C₅-C₆ aryl;

R₂₀, R₂₁ and R₂₂ are independently selected from the group consisting of C₁-C₄ alkyl;

m is 1;

n is an integer ranging from 1 to 50 and

z is 0 or 1.

2. The microfluidic device of claim 1 wherein z is zero and R₁, R₂, R₃, R₄, R₅, R₆, and R₇ are independently selected from the group consisting of C₁-C₁₈ alkyl, C₂-

C₁₈ alkenyl, C₂-C₁₈ alkynyl, C₁-C₈ alkylcarboxyl, C₁-C₈ alkylsulfate, C₃-C₈ cycloalkyl, and C₅-C₆ aryl.

3. The microfluidic device of claim 2 wherein R₁, R₂, R₃, R₄, R₅, R₆, and R₇ are identical.

4. The microfluidic device of claim 1 wherein z is zero and R₁, R₂, R₃, R₄, R₅, R₆, and R₇ are independently selected from the group consisting of C₁-C₈ alkyl, and C₅-C₆ aryl.

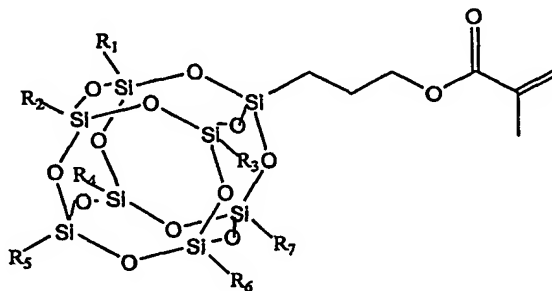
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5. The microfluidic device of claim 1 wherein z is 1, R is phenyl and R₁, R₂, R₃, R₄, R₅, R₆, and R₇ are each C₁-C₃ alkyl.

6. A method of bonding a first silica based substrate to a second substrate wherein said second substrate comprises a silica composition or a polymer, said method comprising the steps of

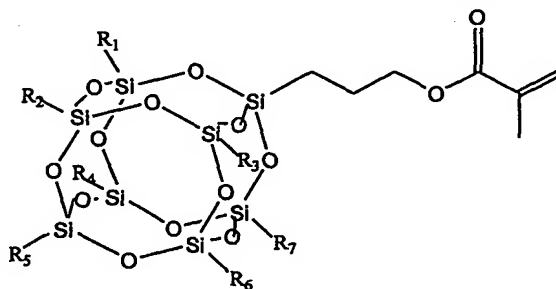
placing a POSS copolymer film between the first and second substrate;
pressing the first and second substrate together for a predetermined length of time to press the POSS copolymer between the first and second substrate; and
heating the POSS copolymer to a temperature ranging from about 100°C to about 200°C.

7. The method of claim 6 wherein the step of placing the POSS copolymer film between the first and second substrate comprises coating a first surface of the first substrate with a composition comprising a polymer produced by polymerizing a mixture comprising methylmethacrylate and a compound of the general structure:



wherein R_1 , R_2 , R_3 , R_4 , R_5 , R_6 , and R_7 are independently selected from the group consisting of C_1 - C_6 alkyl, C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, C_3 - C_8 cycloalkyl, and C_5 - C_6 aryl.

8. The method of claim 6 wherein the step of placing the POSS copolymer film between the first and second substrate comprises coating a first surface of the second substrate with a composition comprising a polymer produced by polymerizing a mixture comprising methylmethacrylate and a compound of the general structure:



wherein R_1 , R_2 , R_3 , R_4 , R_5 , R_6 , and R_7 are independently selected from the group consisting of C_1 - C_6 alkyl, C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, C_3 - C_8 cycloalkyl, and C_5 - C_6 aryl.

9. The method of claim 7 further comprising the step of coating a first surface of the second substrate with said composition prior to the step of pressing the first and second substrate together.

10. The method of claim 6 wherein the first and second substrates are pressed together at a pressure ranging from about 1 MPa to about 24 MPa.

11. The method of claim 6 wherein the second substrate comprises a polymer selected from the group consisting of PMMA, polycarbonate, a POSS copolymer and polyethylene terephthalate.

12. The method of claim 6 wherein the second substrate comprises a silica based substrate having different thermal expansion properties relative to said first silica based substrate.

13. The method of claim 7 or 8 wherein said coating is applied by spin coating.

5 14. The method of claim 6 wherein R_1 , R_2 , R_3 , R_4 , R_5 , R_6 , and R_7 are independently selected from the group consisting of C_1 - C_4 alkyl and C_5 - C_6 aryl.

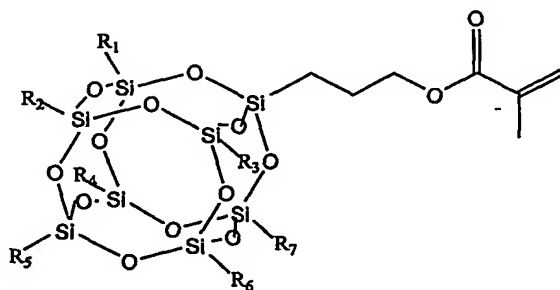
15. The method of claim 14 wherein R_1 , R_2 , R_3 , R_4 , R_5 , R_6 , and R_7 are identical.

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16. A method of preparing a microfluidic device said method comprising the steps of

providing a silica based coverplate, wherein said coverplate comprises a first and second port, and a base, wherein said base comprises a microchannel;

15 coating a surface of the silica based coverplate or the microchannel bearing surface of the base with a first composition comprising a polymer produced by polymerizing a mixture comprising methylmethacrylate, and a compound of the general structure:

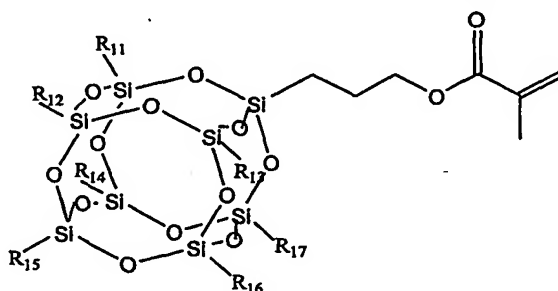


20 wherein R_1 , R_2 , R_3 , R_4 , R_5 , R_6 , and R_7 are independently selected from the group consisting of C_1 - C_6 alkyl, C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, C_3 - C_8 cycloalkyl, and C_5 - C_6 aryl;

contacting the silica based coverplate with the microchannel bearing surface of the base, for a predetermined length of time, in an orientation that places the first and second
25 ports of the coverplate in fluid communication with the microchannel and places the coated surface between the coverplate and the base;

heating the contacted surfaces to a temperature ranging from about 100°C to about 200°C; and

- contacting the inner surface of the microchannel with a second composition comprising a polymer produced by polymerizing a mixture comprising
- 5 methylmethacrylate, and a compound of the general structure:



- wherein R₁₁, R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are independently selected from the group consisting of C₁-C₁₈ alkyl, C₂-C₁₈ alkenyl, C₂-C₁₈ alkynyl, C₁-C₈ alkylcarboxyl, C₁-C₈ alkyl(NR₂₀R₂₁R₂₂)⁺, C₁-C₈ alkyl(NR₂₁R₂₂), C₁-C₈ alkyl(NHR₂₂), C₁-C₈ alkylsulfate, C₃-C₈ cycloalkyl, and C₅-C₆ aryl, wherein R₂₀, R₂₁ and R₂₂ are independently selected from the
- 10 group consisting of C₁-C₄ alkyl.

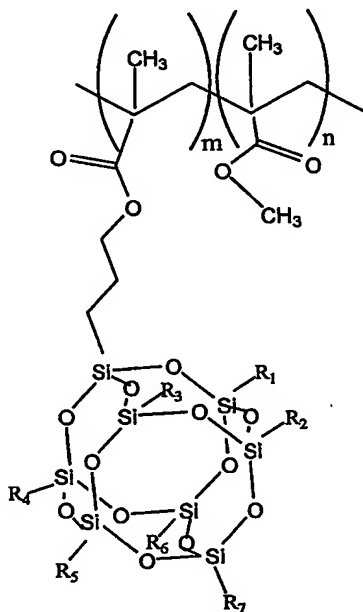
17. The method of claim 16, wherein R₁₁, R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are independently selected from the group consisting of C₁-C₈ alkyl, C₂-C₈ alkenyl, C₂-C₈ alkynyl, C₃-C₈ cycloalkyl, and C₅-C₆ aryl;
- 15

18. The method of claim 16 further comprising the step of contacting the inner surface of the microchannel with an organic solvent after the heating step and prior contacting the microchannel with said second composition.
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19. The method of claim 16 or 18 further comprising the step of contacting the inner surface of the microchannel with a compound selected from the group consisting of NaOH, HCl and HNO₃ after the heating step and prior contacting the microchannel with said second composition.
- 25

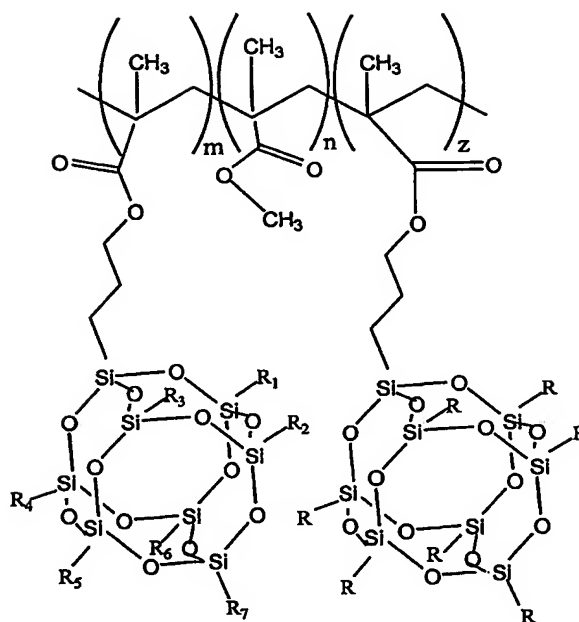
20. A microfluidic device produced by the method of claim 6, 16, 18 or 19.

21. A hybrid microfluidic device, said device comprising
 a silica based component; and
 a polymer component, wherein the silica based component is bonded to the
 polymer component through a polymer film comprising a repeating subunit represented
 5 by the general structure:



- wherein R_1 , R_2 , R_3 , R_4 , R_5 , R_6 , and R_7 are independently selected from the group
 consisting of C_1 - C_6 alkyl, C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, C_3 - C_8 cycloalkyl, and C_5 - C_6
 10 aryl;
 m is 1; and
 n is an integer ranging from 1 to 50.

22. The hybrid device of claim 21 wherein the silica component comprises a
 15 coverplate and the polymer component comprises a body structure formed by said
 polymer, wherein the body structure is provided with a microchannel and an inlet port
 and an outlet port, wherein said inlet port and outlet port are formed on an exterior
 surface of said body structure and are in fluid communication with said microchannel,
 and said microchannel has an interior surface that is coated with a polymer comprising
 20 monomer units represented by the formula:



wherein R, R₁, R₂, R₃, R₄, R₅, R₆, and R₇ are independently selected from the group consisting of C₁-C₁₈ alkyl, C₂-C₁₈ alkenyl, C₂-C₁₈ alkynyl, C₁-C₈ alkylcarboxyl, C₁-C₈ alkyl(NR₂₀R₂₁R₂₂)⁺, C₁-C₈ alkyl(NR₂₁R₂₂), C₁-C₈ alkyl(NHR₂₂), C₁-C₈ alkylsulfate, C₃-C₈ cycloalkyl, and C₅-C₆ aryl;

m is 1;

n is an integer ranging from 1 to 50 and

z is 0 or 1.

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23 The hybrid device of claim 22 wherein said coverplate is provide with two ports that are aligned with the inlet and outlet ports to allow fluid communication between the microchannel and the exterior surface of the device.

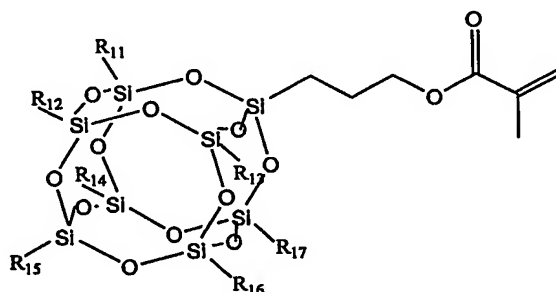
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24. The hybrid device of claim 21 wherein the silica component comprises a first body structure formed from silica oxide, wherein the first body structure is provided with a first microchannel and an inlet port and an outlet port, wherein said inlet port and outlet port are formed on an exterior surface of said first body structure and are in fluid communication with said first microchannel, and said polymer component comprises a second body structure formed by said polymer, wherein the second body structure is provided with a second microchannel having a first and second end, wherein the first end

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of the second microchannel is in fluid communication with said outlet port and the second end of the second microchannel is in fluid communication with the exterior surface of said second body structure.

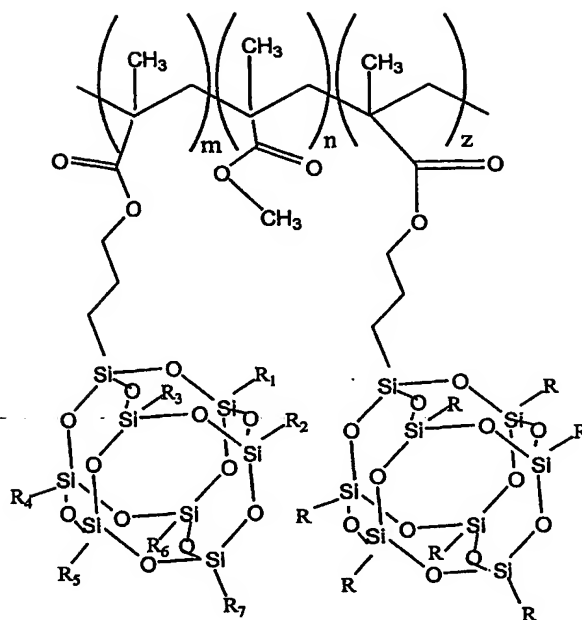
- 5 25. The hybrid device of claim 24 wherein the polymer comprising the second body structure is a polymer produced by polymerizing a mixture comprising methylmethacrylate, and a compound of the general structure:



- 10 wherein R₁₁, R₁₂, R₁₃, R₁₄, R₁₅, R₁₆, and R₁₇ are independently selected from the group consisting of C₁-C₁₈ alkyl, C₂-C₁₈ alkenyl, C₂-C₁₈ alkynyl, C₃-C₈ cycloalkyl, and C₅-C₆ aryl.

- 15 26. The hybrid device of claim 24 wherein the polymer comprising the second body structure is selected from the group consisting of PET, PMMA and polycarbonate.

27. The hybrid device of claim 24 wherein the inner surface of the second microchannel is coated with a polymer comprising monomer units represented by the formula:



wherein R, R₁, R₂, R₃, R₄, R₅, R₆, and R₇ are independently selected from the group consisting of C₁-C₁₈ alkyl, C₂-C₁₈ alkenyl, C₂-C₁₈ alkynyl, C₁-C₈ alkylcarboxyl, C₁-C₈ alkyl(NR₂₀R₂₁R₂₂)⁺, C₁-C₈ alkyl(NR₂₁R₂₂), C₁-C₈ alkyl(NHR₂₂), C₁-C₈ alkylsulfate, C₃-C₈ cycloalkyl, and C₅-C₆ aryl;

m is 1;

n is an integer ranging from 1 to 50; and

z is 0 or 1.

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28. A microfluidic device comprising a first substrate bound to a second substrate via a POSS copolymer wherein the second substrate is provided with a first microchannel and an inlet port and an outlet port, wherein said inlet port and outlet port are formed on an exterior surface of said first substrate and are in fluid communication with said first microchannel.

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29. The device of claim 28 wherein the first substrate comprises a glass coverplate.

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30. The device of claim 29 wherein the second substrate is comprised of glass having different thermal expansion properties than the glass comprising the coverplate.

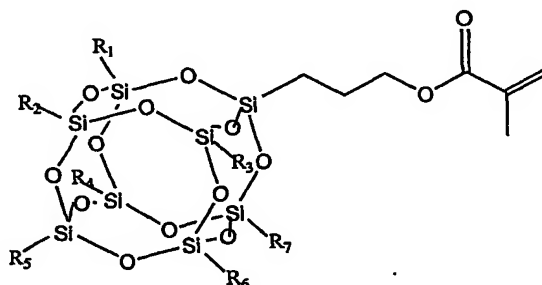
31. The device of claim 29 wherein the second substrate is comprised of a thermoplastic polymer.

32. The device of claim 31 wherein the thermoplastic polymer is PMMA or a POSS copolymer.

33. The device of claim 28 wherein the first substrate and second substrate are both comprised of a thermoplastic polymer.

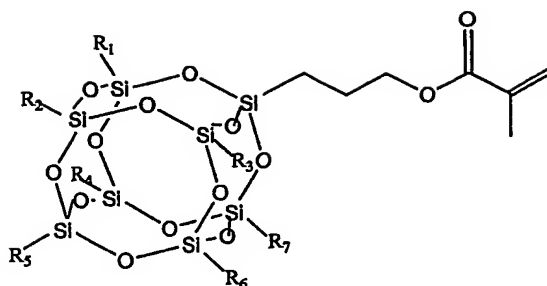
34. The device of claim 33, wherein said first substrate is provided with a second microchannel having a first and second end, wherein the second end of the second microchannel is in fluid communication with said outlet port of the second substrate and the first end of the second microchannel is in fluid communication with an exterior surface of said second substrate.

35. The device of claim 28, 31 or 34 wherein the POSS copolymer is a polymer produced by polymerizing a mixture comprising methylmethacrylate, and a compound of the general structure:



wherein R_1 , R_2 , R_3 , R_4 , R_5 , R_6 , and R_7 are independently selected from the group consisting of C_1 - C_6 alkyl, C_2 - C_6 alkenyl, C_2 - C_6 alkynyl, C_3 - C_8 cycloalkyl, and C_5 - C_6 aryl.

36. The device of claim 34 wherein the first and second microchannels are coated with a POSS copolymer produced by polymerizing a mixture comprising methylmethacrylate, and a compound of the general structure:



wherein R_1 , R_2 , R_3 , R_4 , R_5 , R_6 , and R_7 are independently selected from the group consisting of C_1 - C_{18} alkyl, C_2 - C_{18} alkenyl, C_2 - C_{18} alkynyl, C_1 - C_8 alkylcarboxyl, C_1 - C_8 alkyl($NR_{20}R_{21}R_{22}$)⁺, C_1 - C_8 alkyl($NR_{21}R_{22}$), C_1 - C_8 alkyl(NHR_{22}), C_1 - C_8 alkylsulfate, C_3 - C_8 cycloalkyl, and C_5 - C_6 aryl.